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Network Representation in Army Force-on-Force Models – Reducing the Risk of Irrelevance

MORSS 2005, West Point, New York

21 June 2005

This briefing is UNCLASSIFIED

Agenda

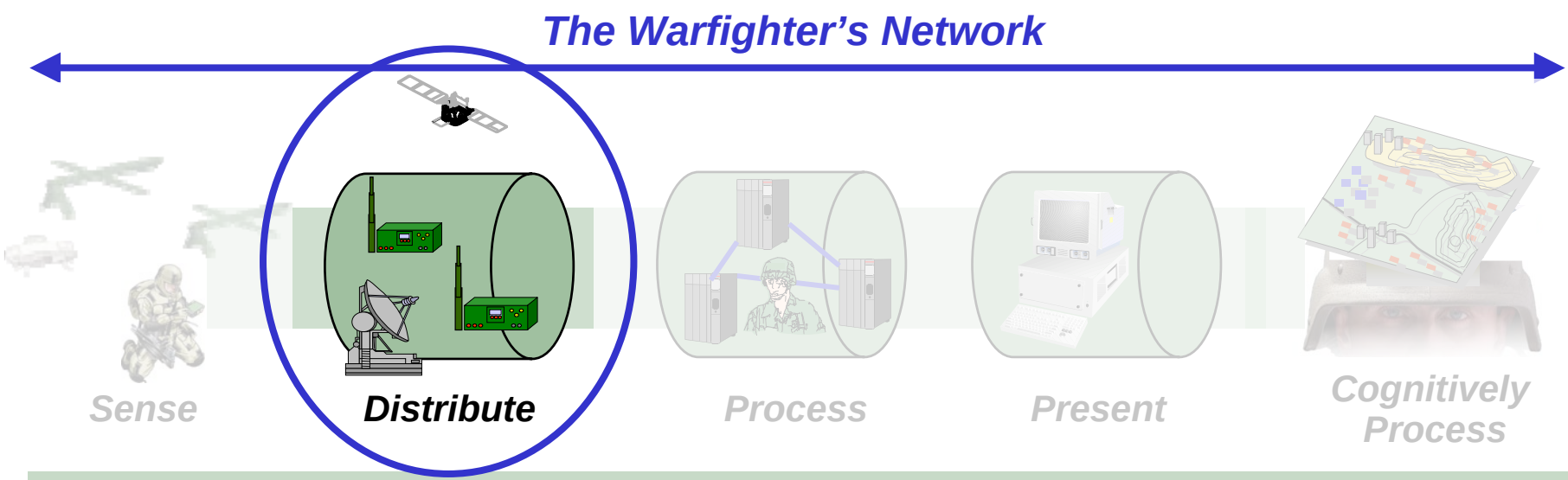
- **The importance of network modeling**
- **Progress in Force-on-Force simulation models**
- **Network modeling challenges**
- **Example: The network data challenge**
- **Overcoming the challenges**

Network Definition and Scope

Network Definition:

Infostructure providing end-to-end movement of data, information & knowledge

Source: " LandWarNet: Network Strategy for Land Combat," TRADOC Futures Center, Dec 03. & "Network Information Brief," TRADOC Futures Center, Aug 03



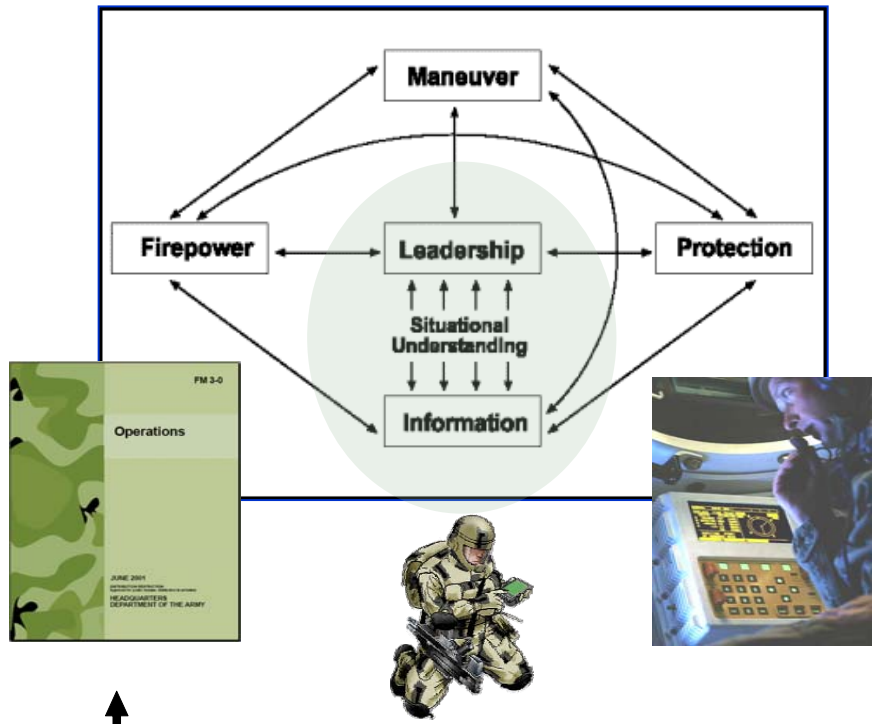
LandWarNet: "The globally interconnected, end-to-end set of Army information capabilities, associated processes, and personnel for collecting, processing, storing, disseminating, and managing information on demand, supporting warfighters, policy makers, warriors, and support personnel."

"LandWarNet - Network Development and Integration White Paper" TRACOC Futures Center, Nov 04

Why this focus?

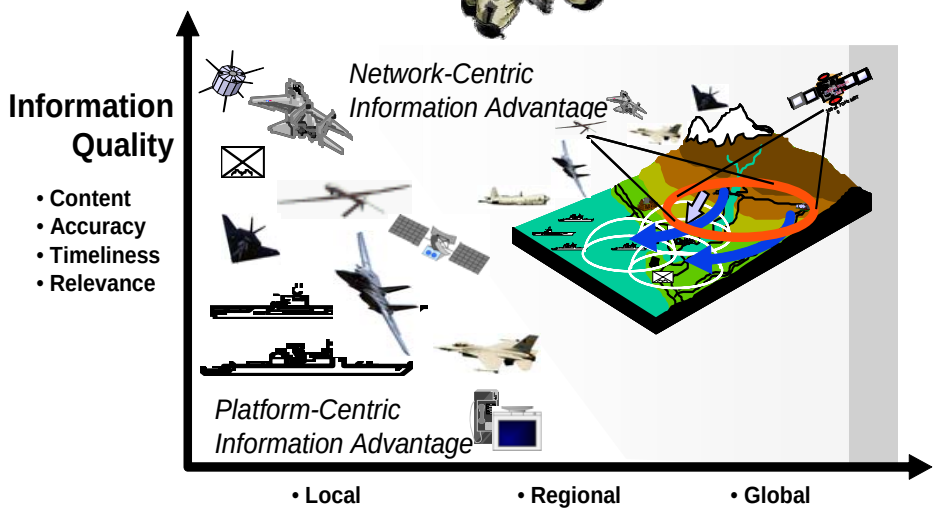
"The two ***truly transforming things***, conceivably, might be in information technology and information operation and ***networking and connecting things*** *in ways that they function totally differently than they had previously*. And if that's possible, what I just said, that possibly the *single-most transforming thing* in our force will not be a weapon system, but ***a set of interconnections*** and a substantially enhanced capability because of that awareness."

-- Secretary Rumsfeld - Aug 9, 2001



"Joint integration and ***improvements in command and control capabilities*** have multiplied the effectiveness of small, agile land forces and ***changed the character of tactical and operational-level warfare***. Operations have become more dispersed across greater spaces, more efficient in use of time and precision strike capabilities, and more capable of collecting, processing, and distributing information. …***Integrating intelligence, fires, and maneuver with advanced information technologies greatly magnifies the effectiveness of small units***."

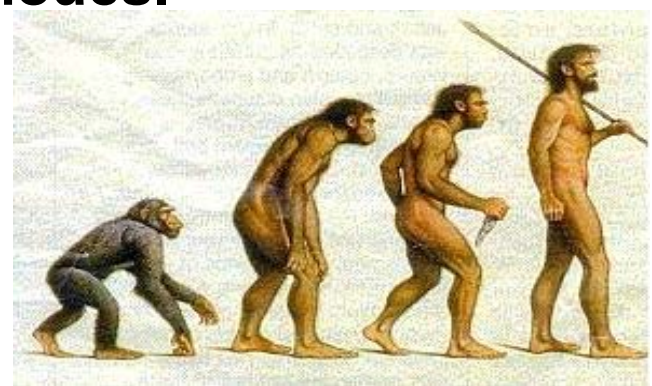
-- Army Comprehensive Guide to Modularity



What was the state-of-the-art?

- **As recently as five years ago, most force-on-force analysis was conducted assuming *largely perfect communications***
  - **Minimally impacted by attrition, terrain, foliage, operational distances or reliability limits,**
  - **Marginally informed by architectural products or organizational options,**
  - **Resistant to enemy activity,**
  - **Capable of providing a continuous flow of information and fusion products, enabled by sensor performance and a minimal location error, to all nodes.**

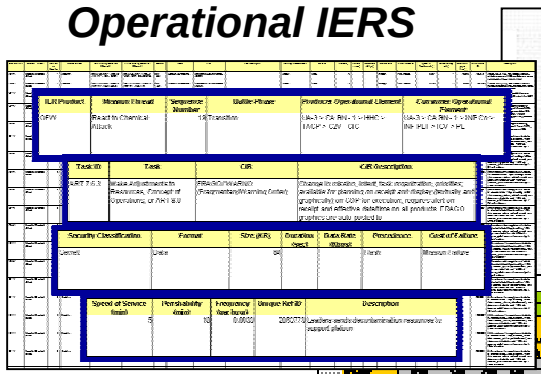
But the capability to model communications has evolved dramatically over the last decade …….



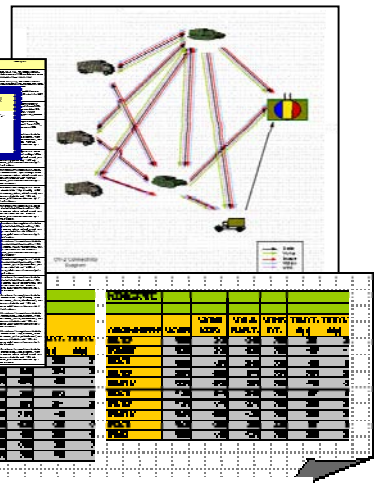
1990s → 2005 →

What do current models represent?

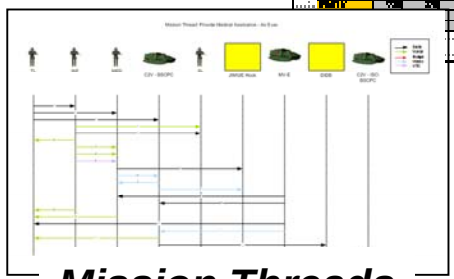
- The expected *Future Force architectural design* to include
  - number of radios and relay nodes by type and location,
  - expected performance characteristics of those systems,
  - loss of those systems due to enemy or mechanical factors.
- The *impact of foliage, distance, and terrain* on the expected performance of the communications systems.
- The capability to represent the *connectivity and throughput* differences *of various network types*.
- The *ability of the threat force* to destroy communications nodes or to deny service through jamming.
- The *user-offered load* (IER-based messages) that is generated based on conditions in the operational environment; *background load* to represent other traffic.
- The ability to assess the *operational impact* of significant changes to the network.



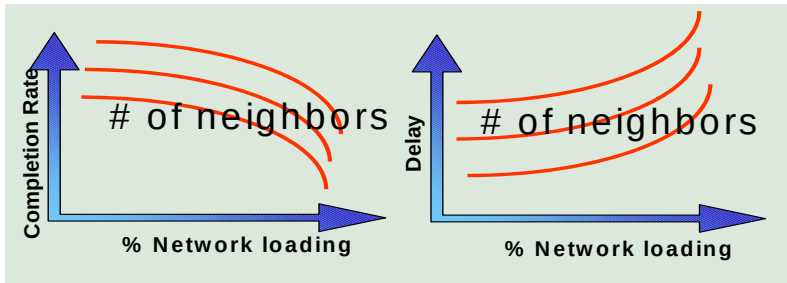
Operational IERS



Bandwidth Estimates over time



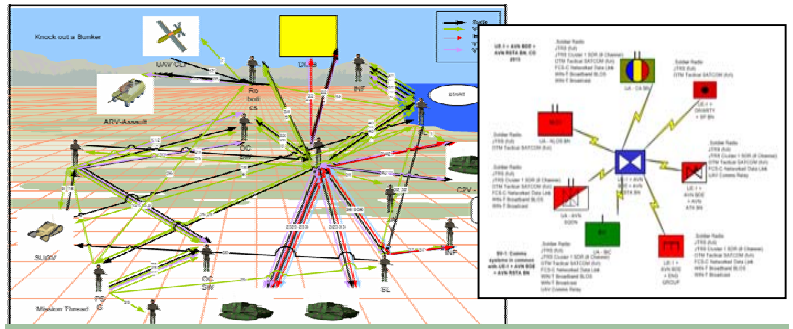
Mission Threads



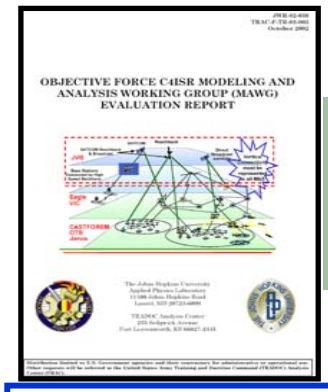
What has enabled this evolution?

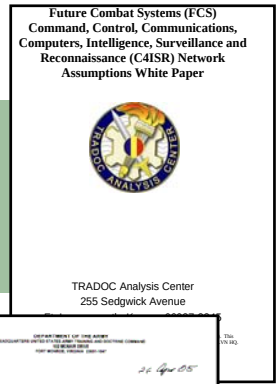
Developing Partnerships

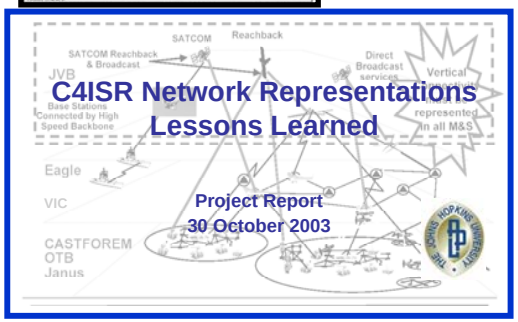
Emerging Architectural Products

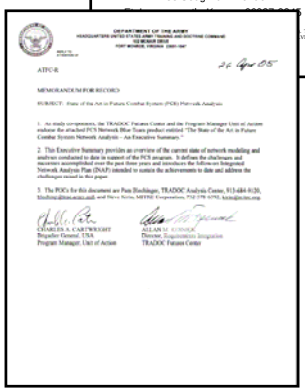


Continuing Self-Assessments

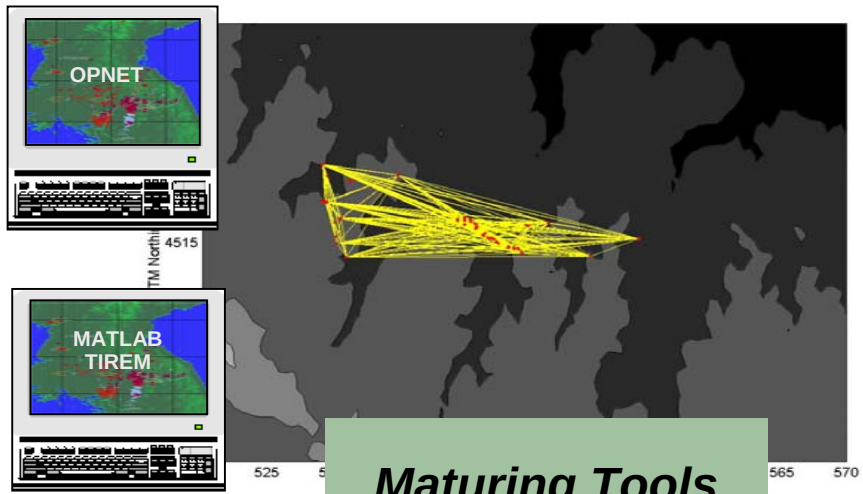






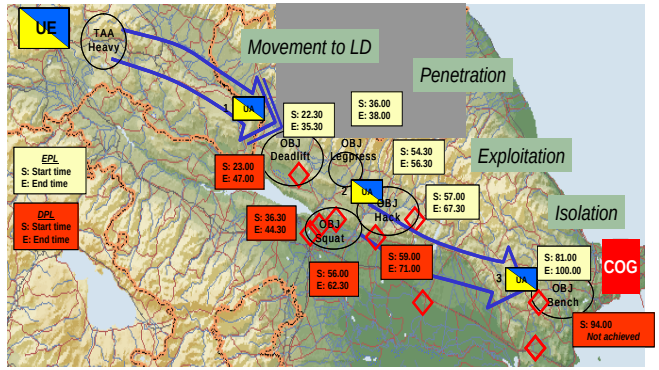


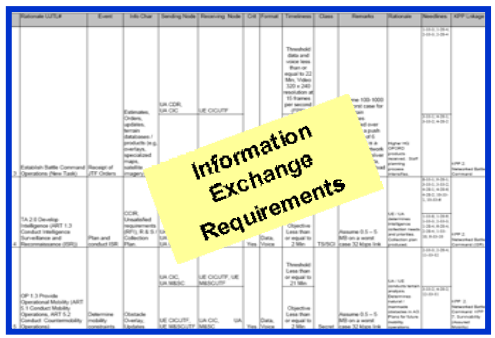
Maturing Tools

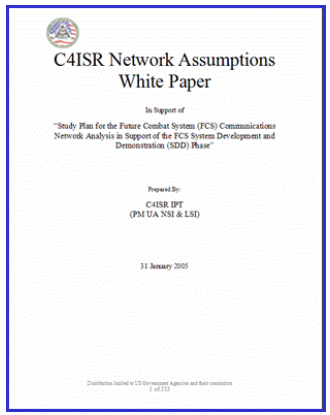


What challenges does this evolution face?

- Development of *scenarios that are more sensitive to information flow* and allow exploration of the *network in urban and complex terrain*.
- *Development of data* that represents all *network traffic* and the performance of the network under very dynamic conditions.
- *Standardization of terms* to define the network and its component elements, characteristics and functions.
- *Documentation of the body of assumptions* about the network being made by various agencies.
- The requirement for *significant computational power* to provide a high fidelity representation of expected traffic loads.
- *Definition of metrics* to assess network performance, the value of information, and contributions of the network to force effectiveness.






C4ISR Network Assumptions White Paper

In Support of

"Study Plan for the Future Combat System (FCS) Communications Network Analysis in Support of the FCS System Development and Demonstration (SDD) Phase"

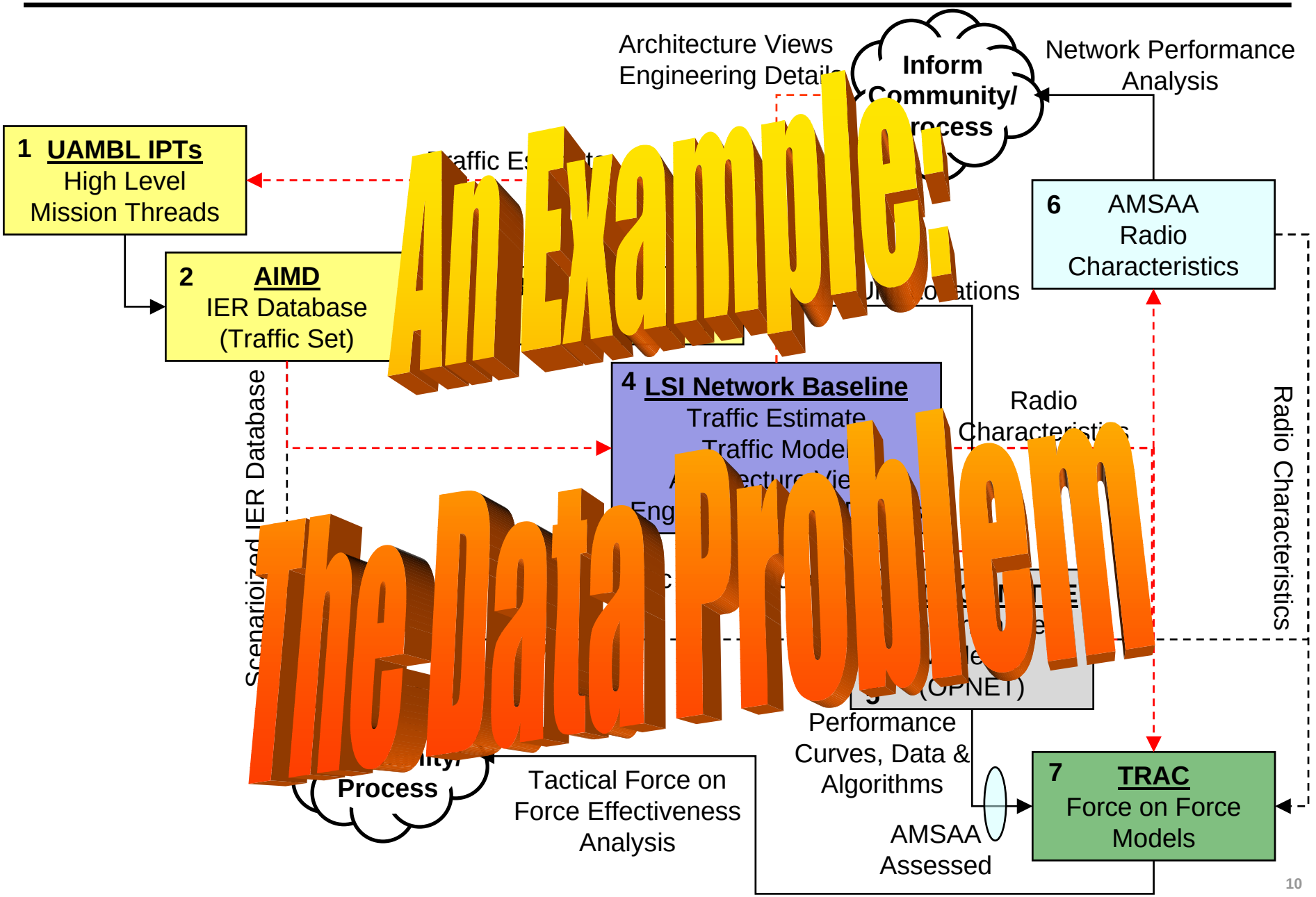
Prepared By:

C4ISR IPT
(PM UA NSI & LSI)

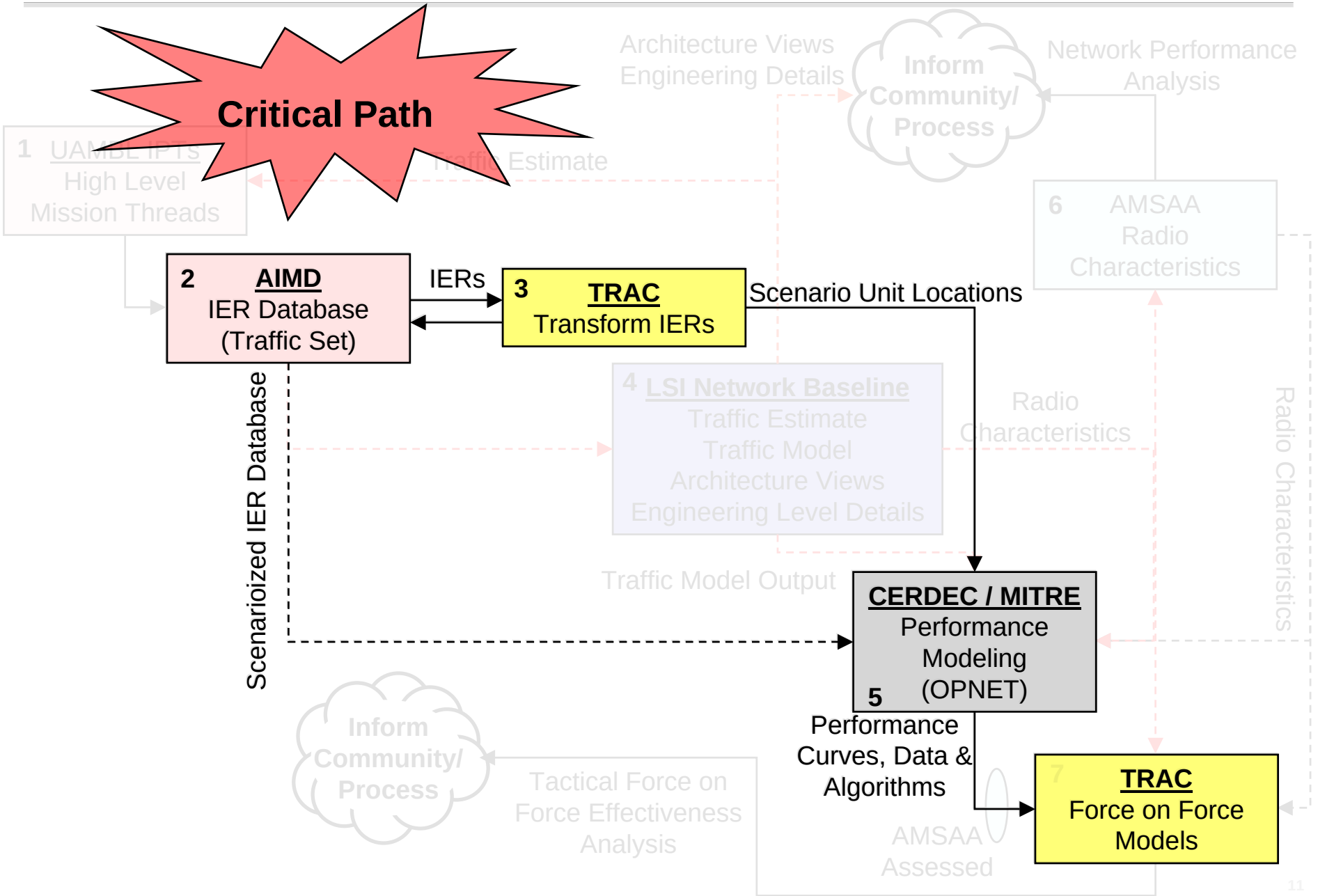
31 January 2003

	Balkans STRYKER Bde*	Caspian UA**
Scenario development time	2.5 mos X 3 personnel	6 mos X 8 personnel
Number of Blue Soldiers/systems	1,887	3,694
Number of Red Soldiers/systems	922	5,221
Number of decision tables	2,224	13,479
Number of combat orders	9,537	62,464
Mission time	33 hrs	44 hrs
Computer run time (1 rep)	4.5 hr	84 hrs
Output file size	.14 GB/rep	7.5 GB/rep
Machine speed	1 GHz	3 GHz
Virtual memory required	128 MB	3 GB

What is our "Communications Data Business Model"?



But is this process sufficiently responsive?



What would cause us to initiate this cycle?

Requirement to Update Network Performance Characterization:

		Process Sensitivity		
		Algorithms	Performance Data	Implicit Mappings
Δ	Force Structure	None	Low	Low
	IERs	None	**Moderate**	**Moderate**
	Scenario	None	Low	**High**
	Comms Systems	**High**	**High**	**Moderate**

"Modeling C4ISR for the Future Combat Systems (FCS) System Development and Demonstration", by Boeing, IBN Technologies, and ITT Aerospace, April 2004.

IERs updated when:

Requirement to Update Traffic Representation (a.k.a. "Scenarioize" IERs):

		IER Sensitivity
Δ	Force Structure	**Moderate**
	Scenario: Timeframe	Low
	Scenario: Entities, Locations, Taskorg	**High**
	CONOPS - Info Flow, Network Services	**High**
	Comms Systems	**Moderate**

Any significant changes to the scenario or communications systems would cause us to generate new network performance data.

And how long does this cycle take?

	Input	Tasks	Products
I. Define Communications Modeling Requirements **(~1 month)** TRAC	• Scenario: - Timeframe - Force Structure - CONOPS • Network OVs/SVs*	• Determine entities that will communicate • Determine device distribution and general network structure	• Identification of comms systems and entities to be modeled • Understanding of general network
II. Develop Network Traffic **(New: ~6 months)** **(Update: ~3 months)** AIMD; BCBL-G	• Scenario: - Force Structure - CONOPS • Network Entities to be modeled	• Select applicable traffic from generic IER database** • Augment or adjust traffic to reflect entities and operation to be modeled • Correlate IERs to scenario events • Identify critical foreground IERs for explicit modeling • Produce scenarioized IER files	• Scenarioized IERs - foreground and background

"Scenarioized" =
- ***Tailored*** to scenario entities
- ***Comprehensive*** for all potential information exchanges
- ***Appropriate*** sizes and frequencies
- ***Time sequenced*** to reflect CONOPS
- ***Prioritized*** for explicit or implicit modeling

* Assumes required **architectures** are available (AIMD validated).
** Assumes representative **generic IER database** is available.

Key Assumptions

… oh, so long?

	Input	Tasks	Products
III. Produce Unit Location Data **(~2 weeks)** TRAC	• Dynamically gamed scenario (maneuver)	• Run maneuver portion of scenario in combat model • Record unit/entity locations	• Entity locations and combat postures -30 minute (max) intervals
IV. Model Network Performance **(New: ~6 months)** **(Update: ~3 months)** CERDEC-MITRE; AMSAA; BCBL-G	• Scenarioized IERs • Entity locations, equipment types, and combat postures • Network architectures and technical data	• Update and validate algorithms and device models as required* • Produce background traffic estimates • Model representative portions of network • Produce performance curves/data • Certify results	•Certified performance data for each system and waveform: - completion rates - delay times - background traffic levels
V. Incorporate Comms Data Into Combat Model **(~1 month)** TRAC	• Performance data	• Map performance data to combat model message sets • Load data; test	• Network representation in force-on-force model

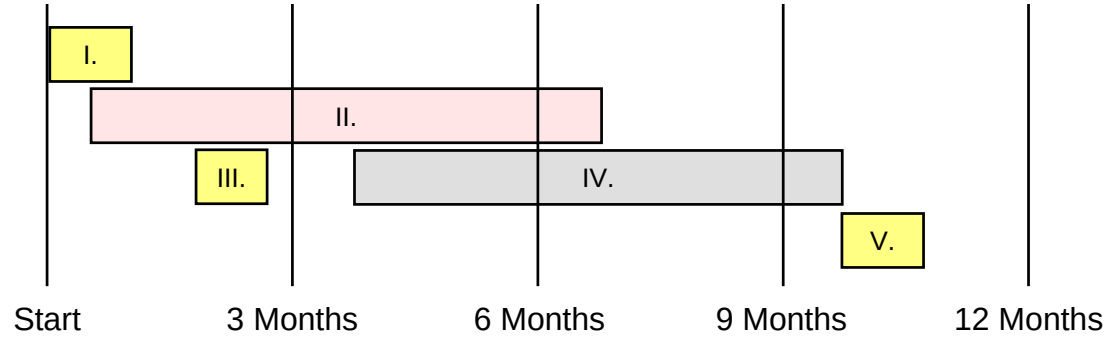
* Assumes required **algorithms and device models** are available.

Key Assumption

What is the impact on specific studies?

Theoretical

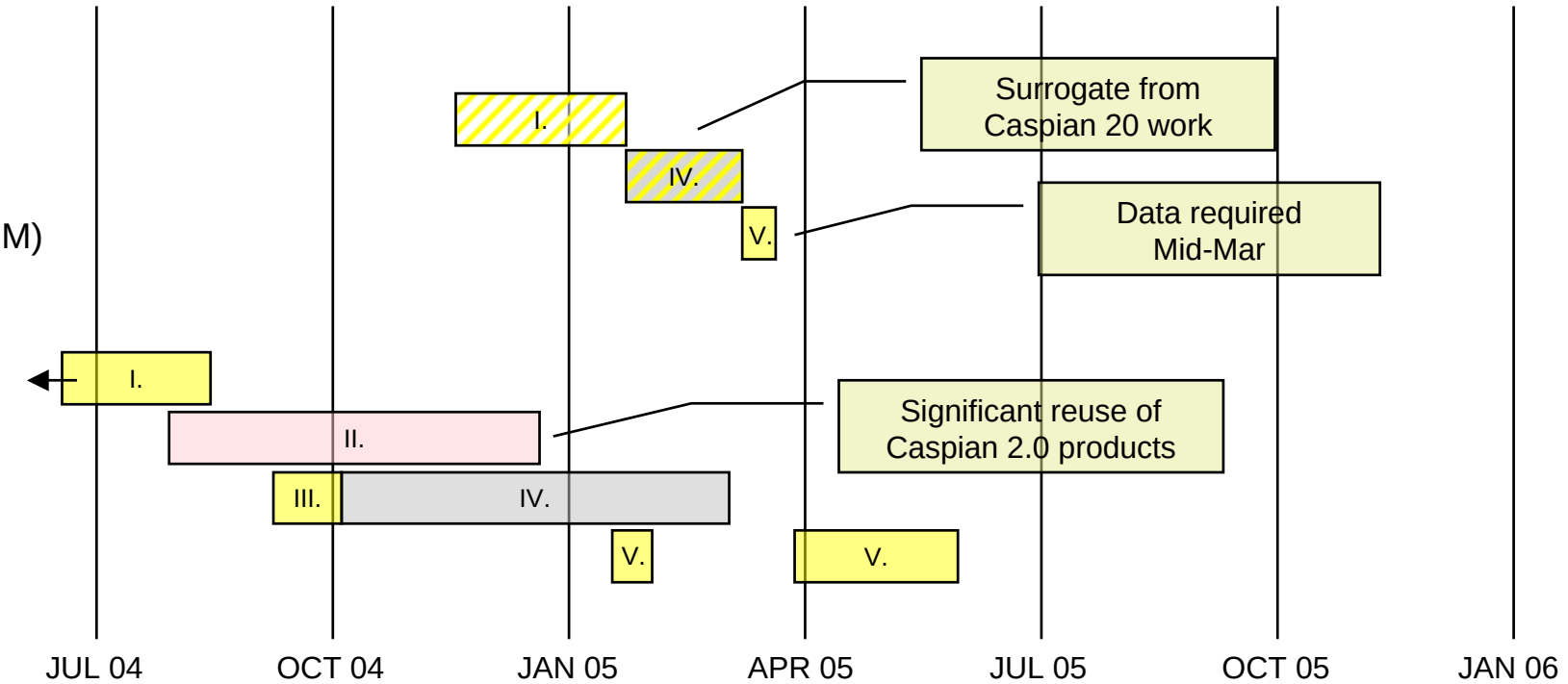
Critical Path



Actual

FCS in NEA 50 (CASTFOREM)

FCS in NEA 5 (VIC)



I. Requirements | II. Traffic | III. Locations | IV. Performance | V. FoF Model Input

What can be done to reduce this timeline?

- **Collaboration**
  - Baseline of current networks
  - Documentation of assumptions
  - Sharing of data and models
  - Standardization of network modeling processes
  - Configuration management of models and data

INAP Purpose

In support of the Integrated FCS Analysis Plan, "recommend steps to integrate the network evaluation process with ongoing FCS program activities and deliverables."

Blue Team Terms of Reference paragraph 5e

Purpose

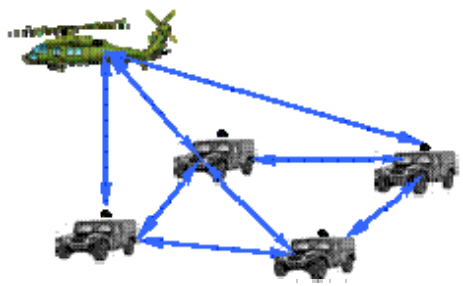
- Set conditions for synchronized, relevant and credible network analysis to understand how the Army will "change, invest & fight as a networked force."
- Provide mechanisms to track the evolution from currently fielded configurations through modernization of the modular units to objective network design.
- Define the issues of concern associated with those configurations. Link the resolution of those issues to key decision points and monitor progress.
- Propose an evaluation framework for the objective and comprehensive evaluation of alternative network design configurations.
- Define the process for developing and maintaining appropriate data sources for network analysis.

But to be effective, some governing body must assume ownership & provide the overwatch, direction, resourcing & management of the plan.

16

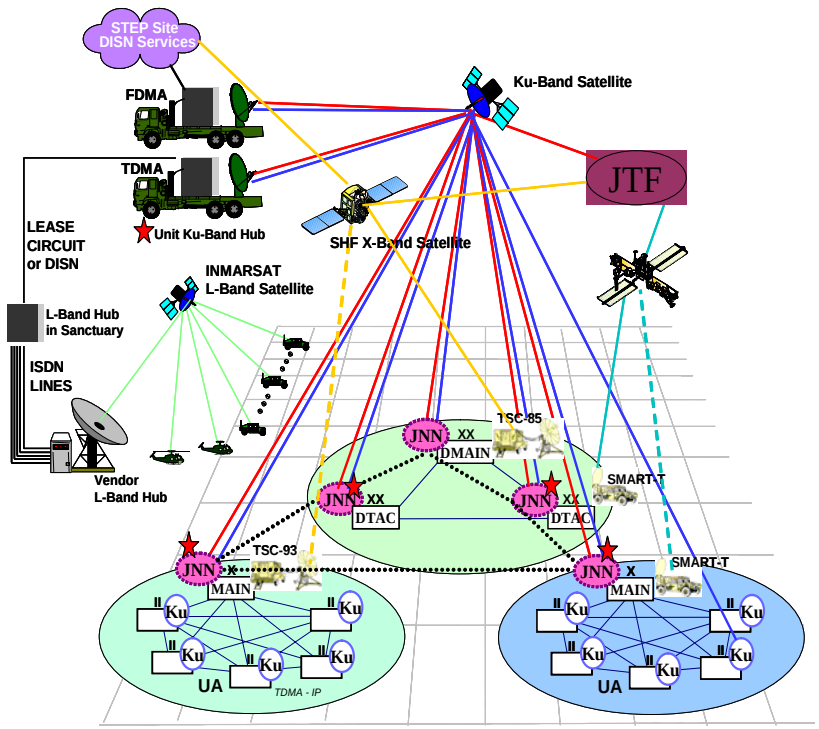
- **Development of Scenario Independent Network Data**
  - Isolation of the key components that drive completion rates and delay
  - Development of network performance data that accounts for:

Sender-Receiver Prototype Pairings
Type Battle Command Software
Combat Postures
Terrain Characterization
Distances
Precedence (Cat I-IV)
UAV Profiles



What must be done to continue the progress?

- Defining and depicting communications for *current and modernized* forces.
- Enhancing the models to better represent the *non-homogeneous force* – SBCT, TF Modularity, FCS BCT.
- Including the *full set of user options* in represented traffic (VOIP, IM, E-mail, VTC etc).
- Replicating the full set of *threat network attack* options.
- Developing data to represent the impact of the *urban environment*.
- Introducing the impact of *Processing and Cognition* in the models.
- Replicating *functionality that will reside in the future network* – automated BDA, distributed fusion, C2 of networked fires.
- Developing an *efficient, sustainable business model* for communications modeling and analysis at engineering performance & force effectiveness levels.



3 ID TF Modularity Architecture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